

WHAT IS CLAIMED IS:

1 1. A motor controller for simultaneously
2 controlling operations of at least two system motors by
3 pulse-width modulation, comprising:

4 a pair of switches for supplying driving power
5 to a pair of system motors among said at least two system
6 motors, respectively;

7 a pair of pulse signal generators for generating
8 a pair of pulse signals respectively having predetermined
9 duty ratios at predetermined cycles, and outputting said
10 pulse signals to said pair of switches to turn on or off
11 said pair of switches; and

12 inversion means for inverting, with respect to
13 a phase of one of said two pulse signals that is generated
14 and output by one of said two pulse signal generators,
15 a phase of the other of said two pulse signals, which is
16 generated and output by the other of said two pulse signal
17 generators, by 180 degrees.

1 2. The motor controller as set forth in claim 1,
2 wherein said one pulse signal is caused to rise at a leading
3 edge of said predetermined cycle, and by inverting the
4 phase of said other pulse signal by 180 degrees by said
5 inversion means, said other pulse signal is caused to fall
6 at said leading edge.

1 3. The motor controller as set forth in claim 1,
2 further comprising:
3 a counter for counting a clock signal,
4 outputting the count to said pair of pulse signal generators,
5 and resetting said count at said predetermined cycles;
6 wherein said pair of pulse signal generators
7 compare said count from said counter with duty set values
8 that are set at said predetermined cycles to determine
9 said predetermined duty ratios, and generate and output
10 said two pulse signals according to the result of comparison,
11 respectively;
12 and wherein said inversion means is constructed
13 as a phase shifter that inverts a phase of said count that
14 is output from said counter to said other pulse signal
15 generator, with respect to a phase of said count that is
16 output from said counter to said one pulse signal generator.

1 4. The motor controller as set forth in claim 1,
2 further comprising restriction means that, when there is
3 overlap of said two pulse signals in which said pair of
4 switches are simultaneously turned on by said one pulse
5 signal and said other pulse signal that is inverted by
6 said inversion means, selects one of said two pulse signals
7 and adjusts a waveform of the selected pulse signal to
8 restrict operation of the switch that is turned on by said
9 selected pulse signal.

1 5. The motor controller as set forth in claim 4,
2 wherein said restriction means comprises:
3 priority-order determination means for
4 determining the priority order of said two system motors,
5 based on the content of a predetermined operation request
6 made on said two system motors and characteristics of a
7 device to be driven by said two system motors;
8 restriction-ratio setting means for setting,
9 based on the content of said predetermined operation
10 request and the characteristics of said device, a
11 restriction ratio of said overlap so that operations of
12 said two system motors, which are performed according to
13 said predetermined operation request, end simultaneously;
14 and
15 adjustment means for selecting as said selected
16 pulse signal a pulse signal that is output to the motor
17 with lower priority determined by said priority-order
18 determination means, and adjusting a waveform of said
19 selected pulse signal according to said restriction ratio
20 set by said restriction-ratio setting means.

1 6. A conveyance robot for conveying a cartridge
2 with a storage medium in a library apparatus that has a
3 shelf for storing said cartridge and a deck for accessing
4 said storage medium, comprising:
5 a hand mechanism for inserting and removing said
6 cartridge while grasping said cartridge;

7 a moving mechanism, which includes two system
8 motors, for two-dimensionally moving said cartridge
9 grasped by said hand mechanism; and
10 a control unit for simultaneously controlling
11 operations of said two system motors by pulse-width
12 modulation;
13 wherein said control unit comprises:
14 a pair of switches for supplying driving power
15 to said two system motors, respectively,
16 a pair of pulse signal generators for generating
17 a pair of pulse signals respectively having predetermined
18 duty ratios at predetermined cycles, and outputting said
19 pulse signals to said pair of switches to turn on or off
20 said pair of switches, and
21 inversion means for inverting, with respect to
22 a phase of one of said two pulse signals that is generated
23 and output by one of said two pulse signal generators,
24 a phase of the other of said two pulse signals, which is
25 generated and output by the other of said two pulse signal
26 generators, by 180 degrees.

1 7. The conveyance robot as set forth in claim 6,
2 wherein said control unit causes said one pulse signal
3 to rise at a leading edge of said predetermined cycle,
4 and by inverting the phase of said other pulse signal by
5 180 degrees by said inversion means of said control unit,
6 said other pulse signal is caused to fall at said leading

7 edge.

1 8. The conveyance robot as set forth in claim 6,
2 wherein:

3 said control unit further comprises a counter
4 for counting a clock signal, outputting the count to said
5 pair of pulse signal generators, and resetting said count
6 at said predetermined cycles;

7 said pair of pulse signal generators compare
8 said count from said counter with duty set values that
9 are set at said predetermined cycles to determine said
10 predetermined duty ratios, and generate and output said
11 two pulse signals according to the result of comparison,
12 respectively; and

13 said inversion means is constructed as a phase
14 shifter that inverts a phase of said count that is output
15 from said counter to said other pulse signal generator,
16 with respect to a phase of said count that is output from
17 said counter to said one pulse signal generator.

1 9. The conveyance robot as set forth in claim 6,
2 wherein said control unit further comprises:

3 restriction means that, when there is overlap
4 of said two pulse signals in which said pair of switches
5 are simultaneously turned on by said one pulse signal and
6 said other pulse signal that is inverted by said inversion
7 means, selects one of said two pulse signals and adjusts

8 a waveform of the selected pulse signal to restrict
9 operation of the switch that is turned on by said selected
10 pulse signal.

1 10. The conveyance robot as set forth in claim 9,
2 wherein said restriction means comprises:

3 priority-order determination means for
4 determining the priority order of said two system motors,
5 based on the content of a predetermined operation request
6 made on said two system motors and characteristics of said
7 moving mechanism to be driven by said two system motors;

8 restriction-ratio setting means for setting,
9 based on the content of said predetermined operation
10 request and the characteristics of said moving mechanism,
11 a restriction ratio of said overlap so that operations
12 of said two system motors, which are performed according
13 to said predetermined operation request, end
14 simultaneously; and

15 adjustment means for selecting as said selected
16 pulse signal a pulse signal that is output to the motor
17 with lower priority determined by said priority-order
18 determination means, and adjusting a waveform of said
19 selected pulse signal according to said restriction ratio
20 set by said restriction-ratio setting means.

1 11. A library apparatus comprising:

2 a shelf for storing a cartridge that houses a

3 storage medium;
4 a deck for accessing said storage medium; and
5 a conveyance robot for conveying said cartridge
6 between said shelf and said deck, comprising:
7 a hand mechanism for inserting and
8 removing said cartridge while grasping said cartridge,
9 a moving mechanism, which includes
10 two system motors, for two-dimensionally moving said
11 cartridge grasped by said hand mechanism, and
12 a control unit for simultaneously
13 controlling operations of said two system motors by
14 pulse-width modulation;
15 wherein said control unit of said conveyance
16 robot comprises:
17 a pair of switches for supplying driving power
18 to said two system motors, respectively,
19 a pair of pulse signal generators for generating
20 a pair of pulse signals respectively having predetermined
21 duty ratios at predetermined cycles, and outputting said
22 pulse signals to said pair of switches to turn on or off
23 said pair of switches, and
24 inversion means for inverting, with respect to
25 a phase of one of said two pulse signals that is generated
26 and output by one of said two pulse signal generators,
27 a phase of the other of said two pulse signals, which is
28 generated and output by the other of said two pulse signal
29 generators, by 180 degrees.

1 12. The library apparatus as set forth in claim 11,
2 wherein said control unit causes said one pulse signal
3 to rise at a leading edge of said predetermined cycle,
4 and by inverting the phase of said other pulse signal by
5 180 degrees by said inversion means of said control unit,
6 said other pulse signal is caused to fall at said leading
7 edge.

1 13. The library apparatus as set forth in claim 11,
2 wherein:

3 said control unit further comprises a counter
4 for counting a clock signal, outputting the count to said
5 pair of pulse signal generators, and resetting said count
6 at said predetermined cycles;

7 said pair of pulse signal generators compare
8 said count from said counter with duty set values that
9 are set at said predetermined cycles to determine said
10 predetermined duty ratios, and generate and output said
11 two pulse signals according to the result of comparison,
12 respectively; and

13 said inversion means is constructed as a phase
14 shifter that inverts a phase of said count that is output
15 from said counter to said other pulse signal generator,
16 with respect to a phase of said count that is output from
17 said counter to said one pulse signal generator.

1 14. The library apparatus as set forth in claim 11,

2 wherein said control unit further comprises:
3 restriction means that, when there is overlap
4 of said two pulse signals in which said pair of switches
5 are simultaneously turned on by said one pulse signal and
6 said other pulse signal that is inverted by said inversion
7 means, selects one of said two pulse signals and adjusts
8 a waveform of the selected pulse signal to restrict
9 operation of the switch that is turned on by said selected
10 pulse signal.

1 15. The library apparatus as set forth in claim 14,
2 wherein said restriction means comprises:

3 priority-order determination means for
4 determining the priority order of said two system motors,
5 based on the content of a predetermined operation request
6 made on said two system motors and characteristics of said
7 moving mechanism to be driven by said two system motors;

8 restriction-ratio setting means for setting,
9 based on the content of said predetermined operation
10 request and the characteristics of said moving mechanism,
11 a restriction ratio of said overlap so that operations
12 of said two system motors, which are performed according
13 to said predetermined operation request, end
14 simultaneously; and

15 adjustment means for selecting as said selected
16 pulse signal a pulse signal that is output to the motor
17 with lower priority determined by said priority-order

18 determination means, and adjusting a waveform of said
19 selected pulse signal according to said restriction ratio
20 set by said restriction-ratio setting means.

1 16. A computer-readable storage medium with a motor
2 control program for causing a computer to realize a
3 motor control function of simultaneously controlling
4 operations of at least two system motors by pulse-width
5 modulation, said motor control program causing said
6 computer to function as:

7 a pair of pulse signal generators for generating
8 a pair of pulse signals, which turn on or off a pair of
9 switches for supplying driving power to a pair of system
10 motors among said at least two system motors, respectively,
11 having predetermined duty ratios at predetermined cycles,
12 and outputting said pulse signals to said pair of switches;
13 and

14 inversion means for inverting, with respect to
15 a phase of one of said two pulse signals that is generated
16 and output by one of said two pulse signal generators,
17 a phase of the other of said two pulse signals, which is
18 generated and output by the other of said two pulse signal
19 generators, by 180 degrees.

1 17. The computer-readable storage medium as set
2 forth in claim 16, wherein:

3 said motor control program causes said computer

4 to function as a counter for counting a clock signal,
5 outputting the count to said pair of pulse signal generators,
6 and resetting said count at said predetermined cycles;
7 said motor control program causes said pair of
8 pulse signal generators to compare said count from said
9 counter with duty set values that are set at said
10 predetermined cycles to determine said predetermined duty
11 ratios, and generate and output said two pulse signals
12 according to the result of comparison, respectively; and
13 said motor control program causes said inversion
14 means to function as a phase shifter that inverts a phase
15 of said count that is output from said counter to said
16 other pulse signal generator, with respect to a phase of
17 said count that is output from said counter to said one
18 pulse signal generator.

1 18. The computer-readable storage medium as set
2 forth in claim 16, wherein said motor control program causes
3 said computer to function as restriction means that, when
4 there is overlap of said two pulse signals in which said
5 pair of switches are simultaneously turned on by said one
6 pulse signal and said other pulse signal that is inverted
7 by said inversion means, selects one of said two pulse
8 signals and adjusts a waveform of the selected pulse signal
9 to restrict operation of the switch that is turned on by
10 said selected pulse signal.

1 19. The computer-readable storage medium as set
2 forth in claim 18, wherein, when said motor control program
3 causes said computer to function as said restriction means,
4 said computer is caused to function as:
5 priority-order determination means for
6 determining the priority order of said two system motors,
7 based on the content of a predetermined operation request
8 made on said two system motors and characteristics of a
9 device to be driven by said two system motors;
10 restriction-ratio setting means for setting,
11 based on the content of said predetermined operation
12 request and the characteristics of said device, a
13 restriction ratio of said overlap so that operations of
14 said two system motors, which are performed according to
15 said predetermined operation request, end simultaneously;
16 and
17 adjustment means for selecting as said selected
18 pulse signal a pulse signal that is output to the motor
19 with lower priority determined by said priority-order
20 determination means, and adjusting a waveform of said
21 selected pulse signal according to said restriction ratio
22 set by said restriction-ratio setting means.